CLAIMS

1. A fastener comprising an elastically deflectable portion having a stiffness characteristic which changes when a load on the fastener is larger than a first load amount, the first load amount being smaller than a limit of elastic deflection of the portion.

2. A fastener according to claim 1, further comprising a shank for extending through a hole in a work-piece.

3. A fastener according to claim 2, wherein the fastener is arranged to apply loading to the work-piece to form a joint.

4. A fastener according to claim 1, wherein the change in the stiffness characteristic is an increase in stiffness.

5. A fastener according to claim 1 , wherein the fastener comprises an elastic element which includes the elastically deflectable portion.

6. A fastener according to claim 5, wherein the elastic element is elastically deflectable in compression.

7. A fastener according to claim 6, wherein the fastener comprises a load bearing surface for contact with an adjacent joint component.

8. A fastener according to claim 7, wherein the adjacent joint component is the work-piece.

9. A fastener according to claim 7, wherein the adjacent joint component is another fastener element.

10. A fastener according to claim 1, wherein the elastic element is resiliently deflectable upon application of a load to the fastener above a second load amount, wherein the stiffness characteristic of the element changes upon the load on the joint being larger than the second load amount.

11. A fastener according to claim 1, wherein the resiliently deflectable portion is resiliently deflectable by virtue of its shape.

12. A fastener comprising a component having a load bearing surface for engaging an external surface of the an adjacent joint component, wherein the load bearing surface comprises a first contact section and a second contact section, wherein the

fastener is resiliently deflectable such that the first contact section contacts the adjacent joint component through a first load amount range and the second load engaging section engages the adjacent joint component upon application of a load on the joint greater than the first load range.

13. A fastener according to claim 12, wherein the component further comprises a curved flange, wherein the load bearing surface is at least party on a concave surface of the curved flange.

14. A fastener according to claim 12, wherein the load bearing surface further comprises a third contact section, wherein the fastener is resiliently deflectable such that the third contact section contacts the adjacent joint component upon application of a load on the joint in a second load amount range greater than the first load amount range.

15. A fastener according to claim 14, wherein the load bearing surface further comprises a fourth contact section, wherein the fastener is resiliently deflectable such that the fourth contact section contacts the adjacent joint component upon application of a load on the joint in a third load amount range greater than the second load amount range.

16. A fastener according to claim 15, where the fastener element is not substantially deflected above the third load amount range.

17. A fastener according to claim 15, wherein the load bearing surface is shaped so that its outermost periphery is included in the first contact section.

18. A fastener according to claim 17, wherein the load bearing surface is shaped so that the second contact section is closer to a longitudinal axis of the fastener than the first contact section.

19. A fastener according to claim 18, wherein the load bearing surface is shaped so that the fourth load contact section is closer to the longitudinal axis than the second contact section.

20. A fastener according to claim 19, wherein the load bearing surface is shaped so that the third contact section is closer to the longitudinal axis than the fourth load contact section.

21. A fastener according to claim 18, wherein the first contact section is a flat annulus.

22. A fastener according to claim 18, wherein the first contact section is inwardly sloped to form a frusto-conical shape.

23. A fastener according to claim 18, wherein the second contact section is inwardly curved.

24. A fastener according to claim 18, wherein the second contact section is a flat annulus.

25. A fastener according to claim 20, wherein the third load contact section is an annular projection.

26. A fastener according to claim 20, wherein, the third contact section is inwardly curved.

27. A fastener according to claim 20, wherein the third contact section is a flat annulus.

28. A fastener according to claim 20, wherein a preload amount applied to the fastener when installed in a joint is in first load amount range.

29. A fastener according to claim 20, wherein a preload amount applied to the fastener when installed in a joint is in second load amount range.

30. A fastener according to claim 12, wherein the first contact section extends in a direction towards the adjacent joint component further than the second contact section when the fastener is in a relaxed state.

31. A fastener according to claim 25 or claim 27, wherein the third contact section is recessed into the fastener element relative to the second contact section when the fastener is in a relaxed state.

32. A fastener according to claim 31, wherein the fourth load contact section is recessed into the fastener element relative to the third contact section when the fastener is in a relaxed state.

33. A fastener according to claim 30, wherein the first contact surface is deflected so as to be level with start of second section after loading the fastener to at least the start of the second load range.

34. A fastener according to claim 31, wherein the first contact surface is deflected so as to be level with start of third section after loading the fastener to at least the start of the third load range.

35. A fastener according to claim 12, wherein the first contact section comprises a plurality of protuberances.

36. A fastener according to claim 12, wherein the fastener comprises a washer.

37. A fastener according to claim 12, wherein the fastener comprises a bolt.

38. A fastener according to claim 12, wherein the fastener comprises a nut.

39. A fastener according to claim 12, wherein the fastener is a rivet.

40. A fastener according to claim 12, wherein the fastener is a pop-rivet.

41. A fastener according to claim 36, wherein the fastener also comprises a second element comprising a shank and a head.

42. A fastener according to claim 41, wherein the second element is an externally threaded fastener component and the fastener further comprises an internally threaded fastener component.

43. A fastener according to claim 42, wherein the externally threaded fastener component is a bolt.

44. A fastener according to claim 42, wherein the internally threaded fastener component is a nut.

45. A fastener according to claim 42, wherein the washer comprises a set of ramp structures arranged to provide increased resistance to rotation of the threaded fastener component in a direction that would loosen the fastener when installed in a joint.

46. A fastener according to claim 45, wherein the ramp structures engage the threaded fastener component.

47. A fastener according to claim 45, wherein the ramp structures engage a further washer located between the first mentioned washer ("retaining washer") and the threaded fastener element.

48. A fastener according to claim 46, wherein the threaded fastener component has a complimentary ramp structure on its surface for abutting the washer.

49. A fastener according to claim 46, wherein at least part of the abutting surfaces of the threaded fastener component and the washer have complimentary frusto-conical surfaces.

50. A fastener according to claim 49, wherein the angle of inclination of the frusto-conical surfaces are such that the threaded fastener component is self-centering on the washer.

51. A fastener according to claim 46, wherein the abutting surface of the washer comprises a frusto-conical surface for engaging a chamfered surface of the threaded fastener component.

52. A fastener comprising an elastic element and a through hole element, wherein the elastic element is adapted to withstand a proof load of the through hole element in an elastic manner with no or minimal plastic flow.

53. A fastener according to claim 1, wherein having a generally domed profile of the work-piece facing surface changes during loading to incorporate a radial line of inflection.

54. A fastener according to claim 1, wherein the stiffness characteristic progressively changes when the fastener is loaded.

55. A joint comprising a fastener according to any one of claims 1 to 54.

56. A joint according to claim 55, further comprising a work-piece having a hole therethrough for receiving the fastener.

57. A joint comprising a work-piece having a through hole and a fastener comprising a component extending through the hole, wherein the fastener has a compact elastic element of an external diameter not exceeding three times nominal size of the fastener and a height not exceeding three quarters of the nominal size of the fastener, resiliently deflectable upon application of a load on the joint up to proof load of the fastener.

58. A fastener assembly for use in a joint in a work-piece comprising:

a first fastener component for extending through a hole in the work-piece, the first component having a first contact portion for engaging the work-piece;

a second fastener component having a second contact portion for co-operating with the first fastener component to compressively load the work-piece thereby forming the joint; and

a resilient element between the first and second contact portions so that it is compressed under load, the element having a resilience under a larger load range than either of the first and second fastener components.

59. A fastener assembly for use in a joint in a work-piece comprising:

a first fastener component for extending through a hole in the work-piece, the first component having a first contact portion for engaging the work-piece;

a second fastener component having a second contact portion for co-operating with the first fastener component to compressively load the work-piece thereby forming the joint; and

a resilient element between the first and second contact portions so that it is it is compressed under load, the element having a resilience under a proof load of the first fastener component.

60. A fastener assembly for use in a joint in a work-piece comprising:

a first fastener component for extending through a hole in the work-piece, the first component having a first contact portion for engaging the work-piece;

a second fastener component having a second contact portion for co-operating with the first fastener component to compressively load the work-piece thereby forming the joint; and

a resilient element between the first and second contact portions so that it is it is compressed under load, the element having a first stiffness characteristic when subjected to loading less than a predefined amount and having a higher stiffness characteristic when subjected to loading more than the predefined amount.

61. A fastener assembly according to any one of claims 58 to 60, wherein the first fastener component is adapted to bear against the work-piece around the hole.

62. A fastener assembly according to any one of claims 58 to 60, wherein the first fastener component is adapted to engage the work-piece from inside the hole through the work-piece.

63. A fastener assembly according to any one of claims 58 to 60, wherein the second fastener element is adapted to bear against the work-piece around the hole.

64. A fastener assembly according to any one of claims 58 to 60, wherein the first fastener component and the resilient element are integrally formed.

65. A fastener assembly according to any one of claims 58 to 60, wherein the second fastener component and the resilient element are integrally formed.

66. A fastener assembly according to any one of claims 58 to 60, wherein the resilient element is in the form of a retaining washer for location between the work-piece and either of the first or second contact portions.

67. A fastener assembly according to any one of claims 58 to 60, wherein the first fastener component is a bolt.

68. A fastener assembly according to any one of claims 58 to 60, wherein the second fastener component is a nut.

69. A fastener assembly according to claim 66, wherein the fastener assembly further comprises a middle washer having a first surface adapted to contact a load bearing surface of retaining washer.

70. A fastener assembly according to claim 69, wherein the second fastener component is a nut is arranged to transfer torque to the middle washer, the middle washer is arranged to rotate relative to the retaining washer.

71. A fastener assembly according to claim 70, wherein the retaining washer is arranged to remain static relative to the work-piece during tightening of the fastener.

72. A fastener for use in a joint in a work-piece comprising:

a first fastener component for extending through a hole in the work-piece, the first component having a first contact portion for engaging the work-piece; and

a resilient element between the first contact portions and the work-piece so that it is compressed under load, the element having a resilience under a larger load range than the first fastener component.

73. A fastener assembly for use in a joint in a work-piece comprising:

a first fastener component for extending through a hole in the work-piece, the first component having a first contact portion for engaging the work-piece; and

a resilient element between the first contact portions and the work-piece so that it is it is compressed under load, the element having a resilience under a proof load of the first fastener component.

74. A fastener assembly for use in a joint in a work-piece comprising:

a first fastener component for extending through a hole in the work-piece, the first component having a first contact portion for engaging the work-piece; and

a resilient element between the first contact portions and the work-piece so that it is it is compressed under load, the element having a first stiffness characteristic when subjected to loading less than a predefined amount and having a higher stiffness characteristic when subjected to loading more than the predefined amount.

75. A fastener assembly for use in a joint comprising:

a fastener component having a load bearing surface;

a retaining washer having a first surface adapted to contact the load bearing surface of the fastener component and a second surface adapted to contact a work-piece, wherein the retaining washer is arranged to be resiliently compressible between its first and second surfaces,

wherein the load bearing surface of the fastener component and the first surface of the retaining washer are provided with a plurality of projections arranged to provide an acoustic indication of the rotation of the fastener component relative to the retaining washer.

76. A fastener assembly according to claim 75, wherein the fastener assembly further comprises a threaded fastener having a load bearing surface, and wherein the fastener component is a middle washer having a threaded fastener contacting surface.

77. A fastener assembly for use in a joint comprising:

a threaded fastener having a load bearing surface;

middle washer having a first surface adapted to contact load bearing surface and the second surface; and

a retaining washer having a first surface adapted to contact the second surface of the middle washer and a second surface adapted to contact a work-piece,

wherein the surfaces between the middle washer and the retaining washer are arranged to increase contact as compression between the threaded fastener and the work-piece increases.

78. A fastener assembly according to claim 77, wherein the second surface of the middle washer is inclined at a first angle to an axis of the washers and the first surface of the retaining washer is at a second angle to the axis, wherein the angles differ such that the contact between the surfaces increases with compression.

79. A fastener assembly according to claim 78, wherein the angles differ such that the increase in contact is directed radially inward.

80. A fastener assembly according to claim 78, wherein the angles differ such that the increase in contact is directed radially outward.

81. A fastener assembly for use in a joint comprising:
a threaded fastener having a load bearing surface;
a middle washer having a first surface adapted to contact the load bearing surface and a second surface; and
a retaining washer having a first surface adapted to contact the second surface of the middle washer and a second surface adapted to contact a work-piece,
wherein the threaded fastener is arranged to transfer torque to the middle washer and the middle washer is arranged to rotate relative to the retaining washer,
wherein the retaining washer is arranged to remain static relative to the work-piece during tightening of the fastener.

82. A fastener assembly according to claim 81, wherein the retaining washer is elastically compressible.

83. A fastener assembly according to claim 81, wherein the middle washer and retaining washer are arranged to have a means for resisting unscrewing movement of the threaded fastener.

84. A fastener assembly for use in a joint comprising:
a threaded fastener having a load bearing surface;
a middle washer having a first surface adapted to contact load bearing surface and the second surface; and
a retaining washer having a first surface adapted to contact the second surface of the middle washer and a second surface adapted to contact a work-piece,
wherein the threaded fastener comprises an external spline drive.

85. A fastener assembly for use in a joint comprising:
a threaded fastener having a load bearing surface;
middle washer having a first surface adapted to contact load bearing surface and the second surface; and
a retaining washer having a first surface adapted to contact the second surface of the middle washer and a second surface adapted to contact a work-piece;
a clutch means for resisting relative movement of the middle washer relative the retaining washer in an unscrewing direction;

a friction lowering means adapted to reduce the friction between the second surface of the first washer and the first surface of the retaining washer.

86. A fastener assembly comprising a compressible elastic portion and an elastically stretchable shank, wherein the elastic portion has a stiffness larger than the stiffness of the shank at a proof load of the shank.

87. A rivet comprising a shank portion and a head portion wherein at least part of the head portion is resiliently deflectable upon application of a load on the rivet up to a first load amount and upon application of a load to the rivet above the first load amount, wherein a stiffness characteristic of the head portion changes upon the load on the rivet being greater than the first load amount.

88. A rivet comprising a shank portion and a head portion, the head portion having a load bearing surface for engaging an external surface of the an adjacent component, wherein the load bearing surface comprises a first contact section, and a second contact section wherein part of the head portion of the rivet is resiliently deflectable such that the first contact section contacts the adjacent component upon application of a load on the rivet within a first load amount range, the second contact section engages the adjacent component upon application of a load on the rivet larger than the first load amount range.

89. A rivet according to claim 88, wherein the load bearing surface comprises a third contact section wherein the third load control section contacts the adjacent component upon application of a load on the rivet greater than a second load amount range.

90. A rivet comprising a shank portion and a head portion, the head portion having:

an annular flange extending from a longitudinal axis, the annular flange comprising a rim for contacting an adjacent component in a first longitudinal direction,

an annular depression positioned inwardly from the rim and

an annular projection around the longitudinal axis extending in the first direction less than the extension of the rim in the first direction when the rivet is in a relaxed state, the projection being positioned radially inwardly from the depression, wherein the shank portion extends in the first longitudinal direction from the annular projection,

wherein when the rivet is subjected to a longitudinal axial load, the rim of the annular flange can deflect in a second longitudinal direction.

91. A bolt comprising a threaded shank portion and a head portion wherein at least part of the head portion is resiliently deflectable upon application of a load on the

bolt up to a first load amount and upon application of a load to the bolt above the first load amount, wherein a stiffness characteristic of the head portion changes upon the load on the bolt being greater than the first load amount.

92. A bolt comprising a threaded shaft portion and a head portion, the head portion having a load bearing surface for engaging an external surface of the an adjacent component, wherein the load bearing surface comprises a first contact section and a second contact section wherein part of the head portion of the bolt is resiliently deflectable such that the first contact section contacts the adjacent component upon application of a load on the bolt within a first load amount range, the second contact section engages the adjacent component upon application of a load on the bolt larger than the first load amount range.

93. A bolt according to claim 92, wherein the load bearing surface comprises a third contact section wherein the third load contact section engages the adjacent component upon application of a load on the bolt greater than the second load amount range.

94. A bolt comprising a threaded shank portion and a head portion, the head portion having:

an annular flange extending from a longitudinal axis, the annular flange comprising a rim for contacting an adjacent component in a first longitudinal direction,

an annular depression positioned inwardly from the rim and

an annular projection around the longitudinal axis extending in the first direction less than the extension of the rim in the first direction when the bolt is in a relaxed state, the projection being positioned inwardly from the depression and the shank portion extends in the first longitudinal direction from the annular projection,

wherein when the bolt is subjected to a longitudinal axial load, the rim of the annular flange can deflect in a second longitudinal direction.

95. A washer comprising a resiliently deflectable portion, wherein the deflectable portion resiliently deflects upon application of a load on the washer up to a first load amount and upon application of a load to the washer above the first load amount, wherein a stiffness characteristic of the deflectable portion changes upon the load on the washer being greater than the first load amount.

96. A washer comprising an aperture and a load bearing surface for engaging an external surface of the an adjacent component, wherein the load bearing surface comprises a first contact section and a second contact section wherein part of the head portion of the washer is resiliently deflectable such that the first contact

section contacts the adjacent component upon application of a load on the washer within a first load amount range, the second contact section engages the adjacent component upon application of a load on the washer larger than the first load amount range.

97. A washer according to claim 96, wherein the load bearing surface comprises a third contact section wherein the third load engaging section engages the adjacent component upon application of a load on the washer greater than a second load amount range.

98. A washer comprising:

an annular flange extending from a longitudinal axis, the annular flange comprising a rim for contacting an adjacent component in a first longitudinal direction,

an annular depression positioned radially inwardly from the rim and

an annular projection around the longitudinal axis extending in the first direction less than the extension of the rim in the first direction when the washer is in a relaxed state,

wherein, when the washer is subjected to a longitudinal axial load, the rim of the annular flange can deflect.

99. A washer according to claim 98, wherein the projection is positioned inwardly from the depression.

100. A washer for use in a joint comprising:

a first surface adapted to contact a first adjacent joint component, a second surface adapted to contact a second adjacent joint component and a curved flange,

wherein the retaining washer is elastically compressible between first and second surfaces and the second surface is formed on the flange,

wherein the retaining washer is substantially bell shaped in appearance.

101. A washer for use in a joint comprising:

a retaining washer having a load bearing surface and a second surface adapted to contact an adjacent joint component,

wherein the retaining washer includes a sleeve that contacts the adjacent joint component when compression between the load bearing surface and the adjacent joint component reaches a predetermined threshold.

102. A washer for use in a threaded fastener joint comprising:

a first load bearing surface for contacting a first joint element, the first load bearing surface being concave (conically or curved) shaped such that the first joint element tends to be self centred on the first load bearing surface;

a second opposite load bearing surface for contacting a second joint element; and

a central aperture extending between the surfaces comprising a socket portion and an inwardly projecting flange for receiving a sleeve portion of the first joint element.

103. A washer for use in a threaded fastener joint comprising:

a first load bearing surface for contacting a first joint element incorporating interlocking means for preventing rotational movement against the threaded fastener;

a second opposite load bearing surface for contacting a second joint element; and

a central aperture extending between the surfaces comprising a socket portion and an inwardly projecting flange for receiving a sleeve portion of the first joint element.

104. A washer according to claim 103 wherein interlocking means are in the form of protrusions that match a mirror profile on the threaded fastener.

105. A washer for use in a threaded fastener joint comprising:

a plurality of ramps in a circular arrangement, the ramps collectively forming a load bearing surface;

a second opposite load bearing surface for contacting a second joint element; and

a central aperture extending between the surfaces comprising a socket portion and an inwardly projecting flange for receiving a sleeve portion of the first joint element.

106. A washer for use in a threaded fastener joint comprising:

a first load bearing surface for contacting a first joint element, the first load bearing surface being concave (conically or curved) shaped such that the first joint element tends to be self centred on the first load bearing surface; and

a second load bearing surface for contacting a second joint element,

wherein the washer is relatively rigid thereby retaining the concave shape under compression between the load bearing surfaces.

107. A retaining washer for use in a threaded fastener joint comprising:

a first surface adapted to contact a fastener element; and

a curved flange having a second surface adapted to contact a work-piece,

wherein the retaining washer is resiliently compressible between the first surface and the second surface,

wherein the second surface is at a distal portion of the flange;

wherein the washer further comprises a sleeve portion positioned inwardly from the second surface, a base of the sleeve portion forming a third surface for contacting the work-piece upon compression of the flange.

108. A retaining washer according to claim 107 where the first surface is adopted to contact of a conventional fastener (bolt or nut).

109. A retaining washer according to claim 108 where the first surface comprises a frusto-conical portion at a rim adapted to center a conventional fastener by contacting a chamfered portion of the fastener.

110. A retaining washer according to claim 109 where the frusto-conical portion is elastic.

111. A retaining washer according to claim 109 where the frusto-conical portion in cooperation with the curved flange act as two elastic washers in series increasing overall fastener deflection.

112. A retaining washer according to claim 107, wherein the sleeve portion extends from inside the curved flange into a dished cavity formed by the curve of the flange.

113. A retaining washer according to claim 107, wherein the flange extends from sleeve portion towards the work-piece beyond the base of the sleeve portion.

114. A retaining washer according to claim 107, wherein the first surface is provided with a plurality of projections arranged to provide greater resistance to rotation of the joint element relative to the retaining washer in contact with the first surface in an unscrewing direction than resistance to rotation of the joint element in a tightening direction.

115. A retaining washer for use in a threaded fastener joint comprising:

an elastic body having a first surface adapted to contact a fastener element and a second surface adapted to contact a work-piece;

wherein the elasticity of the body increases when compression increases.

116. A retaining washer according to claim 115, wherein the increase in stiffness occurs continuously.

117. A retaining washer according to claim 115, wherein the increase in stiffness occurs at a predetermined load.

118. A washer pair combination for use in a joint comprising:
a first washer having a first surface adapted to contact a load bearing surface of another fastener element and a second surface; and
a retaining washer comprising a first surface adapted to contact the second surface of the first washer and a second surface adapted to contact a work-piece,
wherein the second surface of the first washer is convex shaped and the first surface of the retaining washer is concave shaped such that the first washer tends to be self centred on the retaining washer,
wherein the first washer is relatively harder than the second washer.

119. A washer pair combination according to claim 118, wherein the retaining washer is elastically compressible between the first and second surfaces.

120. A washer pair combination for use in a joint comprising:
a first washer having a first surface adapted to contact a load bearing surface of another fastener element and a second surface; and
an elastic retaining washer comprising a first surface adapted to contact the second surface of the first washer and a second surface adapted to contact a work-piece,
wherein the second surface of the first washer is convex shaped and the first surface of the retaining washer is concave shaped such that the first washer tends to be self centred on the retaining washer,
wherein the first washer is relatively non-elastic.

121. A washer pair combination for use in a joint comprising:
a first washer having a first surface adapted to contact a load bearing surface of another fastener element and a second surface; and
a resilient retaining washer comprising a first surface adapted to contact the second surface of the first washer and a second surface adapted to contact a work-piece,
wherein the second surface of the first washer comprises a plurality of protrusions and the first surface of the retaining washer comprises a plurality of complementary protrusions for resisting rotation of the first washer relative to the second washer in an unscrewing direction more than rotation in a tightening direction.

122. A washer pair combination according to claim 121, wherein the protrusions on the second surface of the first washer interact with the protrusions on the retaining

washer to create a sound as the first washer moves relative to the retaining washer in the tightening direction.

123. A washer pair combination for use in a joint comprising:

a first washer having a first surface adapted to contact a load bearing surface of another fastener element and a second convex shaped surface; and

a retaining washer comprising a first concave shaped surface adapted to contact the second surface of the first washer so that the first washer tends to centre itself on the retaining washer, the retaining washer further comprising a second surface adapted to contact a work-piece,

wherein the second surface of the first washer and the first surface of the retaining washer are arranged to increase surface contact with each other as the joint is tightened.

124. A washer pair combination for use in a joint comprising:

a first washer having a first surface adapted to contact a load bearing surface of another fastener element and a second convex shaped surface; and

a retaining washer comprising a first concave shaped surface adapted to contact the second surface of the first washer so that the first washer tends to centre itself on the retaining washer, the retaining washer further comprising a second surface adapted to contact a work-piece,

wherein the second surface of the second washer is arranged to increase surface contact with the work-piece as the joint is tightened.

125. A threaded fastener and washer combination for use in a joint comprising:

a threaded fastener comprising means for preventing rotation on a load bearing surface and a projecting sleeve portion tapering so as to narrow further away from the load bearing surface; and

a washer comprising a load bearing surface having a corresponding means to the means on the threaded fastener, the washer further comprising a socket for receiving the sleeve portion of the fastener.

126. A threaded fastener and washer combination for use in a joint comprising:

a threaded fastener comprising a plurality of ramps in a circular arrangement and a frusto-conical sleeve portion tapering so as to narrow further away from the load bearing surface; and

a washer comprising a plurality of ramps in a circular arrangement collectively forming a first surface adapted to contact the load bearing surface, the washer further comprising a socket for receiving the sleeve portion of the fastener.

127. A threaded fastener and washer combination for use in a joint comprising:

a threaded fastener comprising a first load bearing surface positioned at least one thread revolution inwardly from an axial end of the internally threaded fastener and radially spaced from the thread, the fastener further comprising a frusto-conical sleeve portion tapering so as to narrow further away from the load bearing surface; and

a washer comprising a first surface adapted to contact the load bearing surface, the washer further comprising a socket.

128. A threaded fastener and washer combination for use in a joint comprising:

a threaded fastener comprising a load bearing surface of convex shape; and

a washer comprising a first surface of concave shape adapted to contact the load bearing surface such that the fastener tends to centre itself on the washer,

wherein the washer is relatively harder than the fastener.

129. A threaded fastener and washer combination for use in a joint comprising:

a threaded fastener comprising a load bearing surface of convex shape; and

a washer comprising a first surface of concave shape adapted to contact the load bearing surface such that the fastener tends to centre itself on the washer, the washer further comprising a plurality of projections in a circular arrangement collectively forming a second load bearing surface for cooperating with a joint element to provide greater resistance to relative movement in an unscrewing direction than movement in a tightening direction,

wherein the threaded fastener is resiliently deformable relative to the washer.

130. A threaded fastener and washer combination according to claim 129, wherein the threaded fastener elastically deforms as load is applied between thread of the threaded fastener and the second surface of the washer increases, wherein during elastic deformation of the threaded fastener causes increased contact of the load bearing surface with the first surface of the washer.

131. A fastener and washer combination for use in a joint comprising:

a threaded fastener comprising a convex shaped load bearing surface; and

a washer comprising a concave shaped first surface and resilient curved flange ending in a second surface adapted to contact a work-piece.

132. A fastener and washer combination for use in a joint comprising:

a threaded fastener having a load bearing surface; and

an elastic retaining washer having a first surface and a second surface adapted to contact a work-piece,

wherein the threaded fastener is arranged to rotate relative to the retaining washer, and

wherein the second surface of the retaining washer increases contact with a work-piece as the retaining washer is elastically deformed.

133. A threaded fastener and washer combination according to claim 132, wherein the threaded fastener elastically deforms as load is applied between thread of the threaded fastener and the second surface of the retainer washer increases, wherein elastic deformation of the threaded fastener accompanies increased contact of the load bearing surface with the first surface of the washer.

134. A fastener element comprising:

an annular flange extending from a longitudinal axis, the annular flange comprising a rim for contacting an adjacent component in a first longitudinal direction,

an annular depression positioned inwardly from the rim and

an annular projection around the longitudinal axis extending in the first direction less than the extension of the rim in the first direction when the fastener element is in a relaxed state, the projection being positioned inwardly from the depression,

wherein, when the fastening element is subjected to a longitudinal axial load, the rim of the annular flange can deflect in a second longitudinal direction.

135. A fastener element according to claim 134, wherein the annular flange is able to deflect such that the projection contacts the adjacent component.

136. A fastener element according to claim 134, wherein the arrangement of the rim and the projection are such that the annular flange deflects to the point where projection contacts the adjacent component when the axial load applied to the fastener element reaches a selected amount.

137. A fastener element according to any one of claims 134 to 136, wherein the rim comprises a primary contact portion and a secondary contact portion which can contact the adjacent component when the primary contact portion is in contact with the adjacent component and the fastener element is subjected to an axial load which deflects the annular flange.

138. A fastener element according to claim 137, wherein the primary contact portion is a flat annulus at the periphery of the rim.

139. A fastener element according to claim 138, wherein the primary contact portion is a frusto-conical annulus at the periphery of the rim that in a relaxed state is rising towards the centre of rotation and inwardly.

140. A fastener element according to either claim 136 or 137, wherein the secondary contact portion is inwardly curved.

141. A fastener element according to claim 140, wherein the contact area between the secondary contact portion and the adjacent component increases with the axial load.

142. A fastener element according to either claim 141, wherein the secondary contact portion is a recessed flat annulus concentric with the primary contact portion.

143. A fastener element according to any one claims 142, wherein the rim is provided with a plurality of protuberances for engagement with the adjacent component.

144. A fastener element according to any one of claims 143, wherein the rim has at least one notch for allowing access to the annular projection.

145. A fastener element according to any one of claims 142, wherein the fastening element is a washer comprising a load bearing surface, for contacting a second adjacent component, remote from the rim, and an aperture which is concentric with the longitudinal axis.

146. A fastener element according to claim 145, wherein at least part of the load bearing surface is generally conical in shape.

147. A fastener element according to claim 146, wherein the angle between the inclined surface of the cone and the longitudinal axis is in the range 70° to 85°.

148. A fastener element according to claim 146, wherein the angle between the inclined surface of the cone and the longitudinal axis is between 75° and 80°.

149. A fastener element according to any one of claims 137 to 148, wherein at least an annular portion on the bearing surface has a saw tooth profile, the teeth extending in a circular arrangement around the longitudinal axis.

150. A fastener element according to claim 149, wherein the teeth are formed of a long ramp surface in a third direction and a shorter ramped stopping surface in an opposite fourth direction.

151. A fastener element according to claim 150, wherein the second adjacent component moves up the long ramp surface during loading of the fastener element.

152. A fastener element according to any one of claims 137 to 148, wherein at least an annular portion of the load bearing surface is smooth.

153. A fastener element according to claim 153, wherein the fastener element is a nut, and the head portion comprises means for tool engagement.

154. A fastener element according to any one of claims 137 to 153, further comprising a shaft extending from the annular flange concentric with the longitudinal axis.

155. A fastener element according to claim 154, wherein the shaft is generally cylindrical with a diameter less than the diameter of the end of the projection.

156. A fastener element according to either claim 154 or 155, wherein the surface remote from the rim forms a head portion.

157. A fastener element according to claim 156, wherein the fastener element is a bolt, and the head portion forms the head of a bolt.

158. A fastener element according to any one of claims 154 to 157, wherein the shaft is provided with a threaded portion.

159. A fastener element according to claim 158, wherein the fastener element is a rivet, and the head portion forms the head of a rivet.

160. A fastener element according to claim 158, wherein the fastener element is a pop-rivet, and the fastener element further has a cylindrical aperture which is concentric with the longitudinal axis.

161. An internally threaded fastener comprising:

a first load bearing surface positioned at least one thread revolution inwardly from an axial end of the internally threaded fastener and radially spaced from the thread; and

a frusto-conical sleeve portion tapering so as to narrow further away from the load bearing surface.

162. A threaded fastener according to claim 161, wherein the internal thread extends into the sleeve portion.

163. An externally threaded fastener for use in a joint comprising:
a head; and
an externally threaded shank extending from a first axial end of the head;
the head comprising a first load bearing surface positioned inwardly of the first axial end of the head and radially spaced from the shank; and a frusto-conical sleeve portion tapering so as to narrow further away from the load bearing surface, the external surface of the sleeve portion forming a second load bearing surface.

164. A threaded fastener for use in a joint comprising:
a plurality of ramps in a circular arrangement positioned at least one thread revolution inwardly from an axial end of the threaded fastener and radially spaced from the thread; and
a frusto-conical sleeve portion tapering so as to narrow further away from the ramps.

165. A threaded fastener for use in a joint comprising:
a plurality of ramps in a circular arrangement, the ramps collectively forming a load bearing surface, the ramps positioned at least one thread revolution inwardly from an axial end of the internally threaded fastener and radially spaced from the thread; and
a frusto-conical sleeve portion tapering so as to narrow further away from the load bearing surface, the external surface of the sleeve portion forming a second load bearing surface.

166. A method of loading a joint in a work-piece comprising a fastener to a desired load comprising:
providing a fastener having a means for determining the amount of loading in the joint;
detecting when the amount of load reaches the desired load;
wherein the means provides an indication of discrete increases in the load.

167. A method according to claim 166, wherein the means provides an audible indication of the discrete increase.

168. A method according to claim 166, wherein the means provides a visual indication of the discrete increase.

169. A method of loading a joint in a work-piece comprising a fastener to a predetermined load comprising:

providing a fastener having a means for changing the perceivable stiffness in the joint when the load in the joint reaches the predetermined amount;

detecting when the amount of load reaches the desired load.

170. A method according to claim 169, wherein the means is in the form of a surface contacting an adjacent joint component thereby changing the stiffness characteristic of the fastener.

171. A method according to claim 166 or 169, wherein the desired/predetermined amount is about 90%-100% of the proof load of a component of the joint having a shank.

172. An joint element for a threaded fastener assembly, the joint element comprising:

a body having a central axis, the body having first and second load bearing faces between which the body can be subjected to compression upon tightening of the threaded fastener assembly, and a central hole extending through the body along the central axis, the body being elastically deformable when subjected to compression, characterised in that the elastic stiffness of the body increases during loading under compression once the body has undergone deflection beyond a predetermined extent.

173. An joint element according to claim 172, wherein the change in stiffness occurs as a single step.

174. An joint element according to claim 172, wherein the fastener assembly includes a bolt and a nut in threaded engagement, wherein the stiffness of the body changes from a lower stage to a higher stage, with the lower stage corresponding generally to the elastic range of the bolt and the higher stage being beyond the elastic range of the bolt.

175. An joint element according to claim 172, wherein the first engaging face is inclined to a plane normal to the central axis of the elastic element at an angle of no more than about 15° to said plane.

176. An joint element according to claim 175, wherein the angle of the face allows centring of the element in relation to the adjacent part of the assembly.

177. An joint element according to claim 172, wherein the elastic element behaves as a clutch.

178. An joint element according to claim 177, wherein when a torque larger than that expected to occur during operation is applied to the member in contact with the elastic element in the unscrewing direction the member will be riding on the ramp shoulder and dropping onto the adjacent ramps, ultimately releasing tension in the assembly.

179. An joint element according to claim 178, wherein the joint element is constructed in such a way that torque transferred through the engaging face during unscrewing is larger than that transferred through the clutch.

180. An joint element according to claim 172, wherein the changing stiffness characteristic as a generally linear relationship of forces as a function of deflection has certain inclination leading towards proof load of the externally threaded element of the joint, and further loading beyond that value results in lesser elongation per unit force.

181. An joint element according to claim 172, wherein means is provided for reducing frictional resistance the first face and a rotatable element relative movement therebetween corresponding to tightening of the threaded fastener assembly.

182. An joint element according to claim 181, wherein the means is in the form of a lubricant.

183. An joint element according to claim 182, wherein the means is in the form of rollers facilitating relative movement between mating ramp structures of the first face and the rotatable element at lower frictional resistance.

184. An joint element according to claim 172, wherein the second engaging face includes a curved configuration, wherein the curved configuration involves concavity and a point of inflection at which the concavity reverses, the concavity being inwardly facing on the radially outerside of the point of inflection and outwardly facing on the radially inwardly side of the point of inflection.

185. An joint element according to claim 184, wherein the second engaging face further includes a flat section and a further section radially inward of the flat section, the further section being of said curved configuration.

186. An joint element according to claim 172, wherein the body further includes a flange portion extending inwardly to an inner periphery thereof extending around the central hole, the inner periphery being at a diameter smaller than the inner diameter of each of the engaging faces.

187. An joint element according to claim 172, wherein the body of the elastic element has means for providing an indication of the extent of relative rotation between the rotatable element and the elastic element following initial engagement therebetween.

188. An joint element according to claim 187, wherein the indication is in the form of a visual indication.

189. An joint element according to claim 187, wherein the indication is an acoustic indication.

190. A threaded fastener assembly comprising an elastic element comprising:

a body having a central axis, the body having first and second engaging faces between which the body can be subjected to compression upon tightening of the threaded fastener assembly, and a central hole extending through the body along the central axis, the body being elastically deformable when subjected to compression, characterised in that the elastic stiffness of the body increases during loading under compression once the body has undergone deflection beyond a predetermined extent.

191. An joint element comprising:

a body having a central axis, the body including an outer periphery, an inner periphery defining a central aperture, a first side being provided with a structure for interaction with an adjacent component of a joint assembly to provide a mechanical connection therebetween, and a second side defining a curved engaging face.

192. An joint element according to claim 191, wherein the curved engaging face is concaved and has a point of inflection at which the concavity reverses, the concavity being inwardly facing on the radially outerside of the point of inflection and outwardly facing on the radially inwardly side of the point of inflection.

193. An joint element according to claim 191, wherein the further engaging face further includes a flat section and a further section radially inward of the flat section, the further section being of said curved configuration.

194. An joint element according to claim 191, wherein the body further includes a flange portion extending inwardly to an inner periphery thereof extending around the central hole, the inner periphery being at a diameter smaller than the inner diameter of each of the engaging faces.

195. A threaded fastener assembly for releasably securing a work-piece in position, the threaded fastener assembly comprising:

a threaded fastener having an axis of rotation,

an elastic element presenting an annular engaging face concentric with said axis of rotation for engaging the work-piece,

means providing a mechanical connection between the threaded fastener and the elastic element facilitating rotation of the threaded fastener relative to the elastic element in a tightening direction while resisting relative rotation in a unscrewing direction,

wherein the threaded fastener comprises an assembly of first and second fastener members, the first fastener member comprising a head portion and a projection portion extending axially from the head portion, with an engaging face on the head portion surrounding the projection portion, the second fastener member comprising a first engaging face, a second engaging face and a central hole for receiving the projection portion of the first fastener member with a clearance fit and with the engaging face of the first fastener member in engagement with the first engaging face of the second fastener member, the second engaging face of the second fastener member being in engagement with the elastic element.

196. A threaded fastener assembly according to claim 195, wherein a mechanical connection between the engaging face of the first fastener member and the first face of the second fastener member is adapted to urge the first and second fastener members axially apart in response to rotation of the first fastener member relative to the second fastener member in the unscrewing direction.

197. A threaded fastener assembly according to claim 196, wherein the mechanical connection is a spline-like connection between the first and second fastener members.

198. A threaded fastener assembly according to claim 195, wherein the face of the elastic element engaging the work-piece may be provided with means for inhibiting rotation of the elastic element relative to the work-piece.

199. A threaded fastener assembly according to claim 198, wherein the means comprise one or more discrete embedding protrusions on the elastic element adapted to embed in the work-piece at low loads.

200. A threaded fastener assembly according to claim 199, wherein each embedding protrusion may be defined by an integral tooth configured to embed in the work-piece.

201. A threaded fastener assembly according to claim 195, wherein the threaded fastener assembly is provided with means for providing a visual indication of the extent to which the threaded fastener assembly is preloaded.

202. A threaded fastener assembly according to claim 201, wherein the visual indication is achieved by way of a scale allowing the extent of rotation of the fastener relative to the elastic element to be determined after initial frictional contact therebetween whereby the extent of such rotation determines the preload on the threaded fastener assembly.

203. A threaded fastener assembly according to claim 195, wherein the mechanical engagement between the fastener and the elastic element generates an audible sound upon rotation of the fastener relative to the elastic element in the tightening direction after initial engagement therebetween.

204. A threaded fastener assembly according to claim 203, wherein such sound is utilised to regulate the extent of preload on the fastener assembly, as each sound corresponds to a specific amount of angular rotation of the fastener and hence a specific incremental force imposed thereby.

205. A threaded fastener assembly according to claim 204, wherein a prescribed number of sounds are specified to tighten the fastener.

206. A threaded fastener assembly for releasably securing a work-piece in position, the threaded fastener assembly comprising:

a threaded fastener having an axis of rotation, the threaded fastener presenting an annular engaging face concentric with said axis of rotation for engaging the work-piece or another component of the threaded fastener assembly, the threaded fastener comprising an assembly of first and second fastener members, the first fastener member comprising a head portion and a projection portion extending axially from the head portion, with an engaging face on the head portion surrounding the projection portion, the second fastener member comprising an engaging face and a central hole for receiving the projection portion of the first fastener member with a clearance fit and with the engaging face of the first fastener member in engagement with the engaging face of the second fastener member, said annular engaging face being provided on the second fastener member on the opposed side thereof the engaging face.

207. A threaded fastener assembly for releasably securing a work-piece in position, the threaded fastener assembly comprising a threaded fastener component and a second component, the threaded fastener component having an axis of rotation and presenting an annular engaging face concentric with said axis of rotation for

engaging the elastic element, the threaded fastener component also having a chamfered portion surrounding the annular engaging face, the second component comprising a frusto-conically shaped flange for engaging the chamfered portion for allowing the threaded fastener component to be self-centred on a first face of the second component.

208. A washer for use in a fastener assembly for releasably securing a work-piece in position, the fastener assembly comprising a threaded fastener component having an axis of rotation and presenting an annular engaging face concentric with said axis of rotation for engaging the elastic element, the threaded fastener component also having a chamfered portion surrounding the annular engaging face, the washer comprising a frusto-conically shaped flange surrounding a load bearing face for engaging the chamfered portion for allowing the threaded fastener component to be self-centred on the load bearing face.

209. A washer according to claim 208, wherein the washer further comprises a curved resiliently deflectable flange for engaging the work-piece to provide an elastic characteristic to the washer.

210. A washer according to claim 208, wherein a frusto-conically shaped flange is resiliently deflectable to provide an elastic characteristic to the washer.

211. A washer according to claim 208, wherein the washer further comprises a curved resiliently deflectable flange for engaging the work-piece, and wherein the a frusto-conically shaped flange is resiliently deflectable to provide a series of elastic elements, thereby increasing deflection of the washer.

212. A washer according to claim 208, wherein the frusto-conically shaped flange has ratchet teeth to prevent rotation of the threaded fastener component in an unscrewing direction.